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NATIONAL DAM INSPECTION PROGRAM. LLOYDELL DAM (ID NUMBER PA 500--ETC(U)
JUN 78 DACW31-78-C-0049
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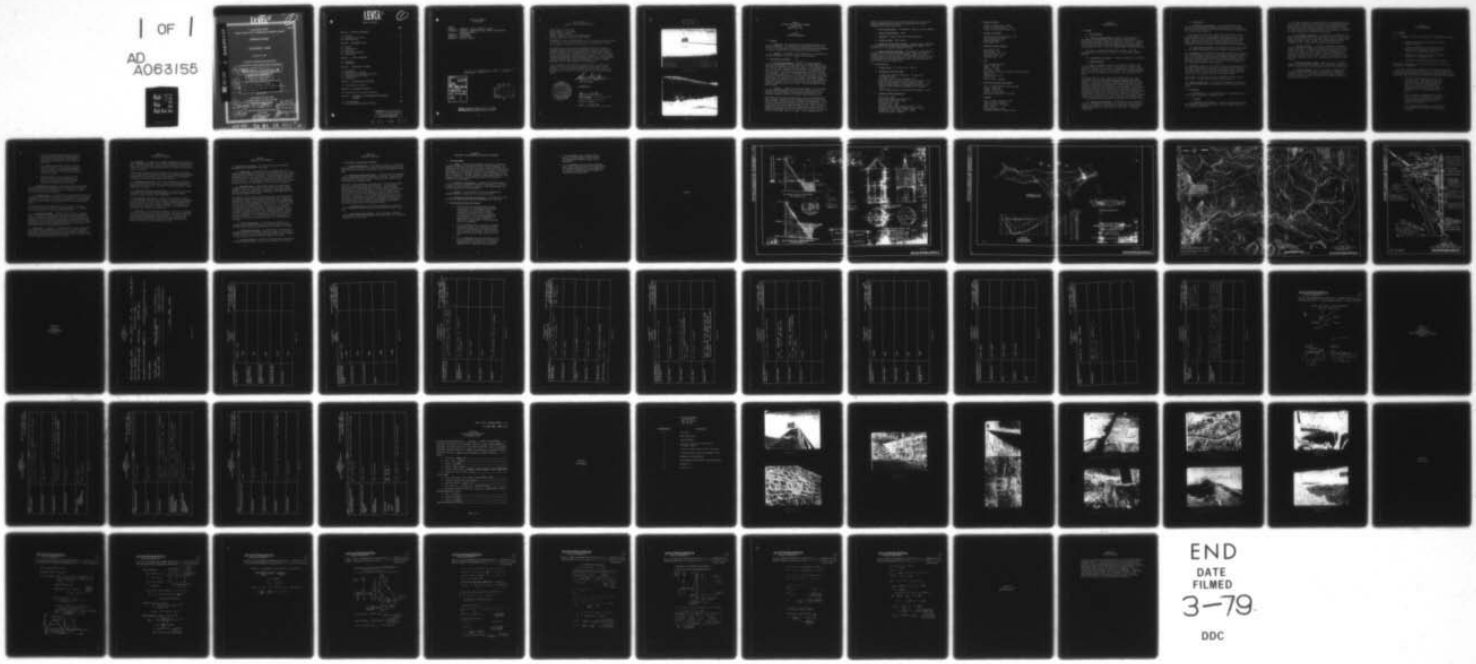

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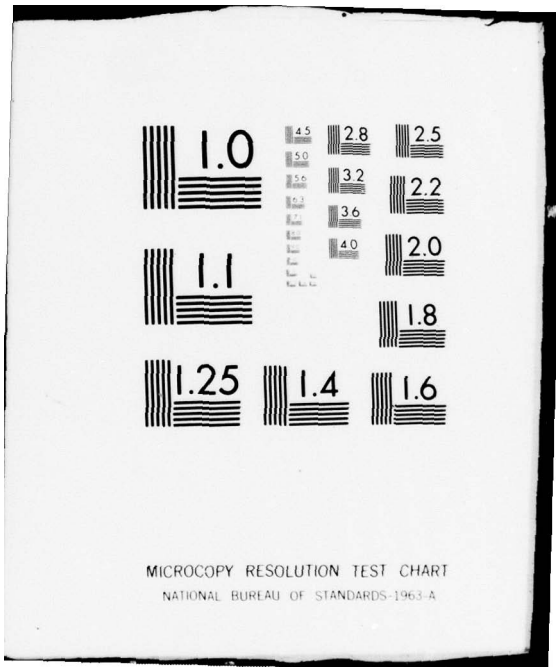
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NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL II

OHIO RIVER BASIN

SOUTH FORK LITTLE CONEMAUGH, CAMBRIA COUNTY

PENNSYLVANIA

LLOYDELL DAM

(ID NO. PA. 500)

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

(21) ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

(6) National Dam Inspection Program. Lloydell Dam (ID Number PA 500), Ohio River Basin, South Fork Little Conemaugh, Cambria County, Pennsylvania. Phase I Inspection Report,

PREPARED FOR

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT, CORPS OF ENGINEERS

BALTIMORE, MARYLAND 21203

(15) DACW31-78-C-0049

D'APPOLONIA CONSULTING ENGINEERS

10 DUFF ROAD

PITTSBURGH, PA. 15235

(12) 65 p.

(11) JUNE 1978

LEVEL II

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TABLE OF CONTENTS
(Continued)

Contract DACW31-78-C-0049

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Lloydell Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Cambria
STREAM: South Fork of Little Conemaugh River
DATE OF INSPECTION: (May 18 and 30, 1978)

(cont'd p 1)

ASSESSMENT: Based on the evaluation of the conditions as they existed on the dates of inspection and as revealed by visual observations, the condition of Lloydell Dam is assessed to be good.

The spillway does not have the recommended capacity to pass the probable maximum flood without overtopping. However, the dam is a masonry structure, and overtopping by the probable maximum flood would not significantly affect the stability of the dam. Therefore, the spillway capacity is considered to be adequate. However, during unusually heavy runoff, when overtopping might occur, an around-the-clock surveillance plan should be implemented to detect possible problems, such as rapid erosion of the abutments.

It is recommended that the owner should develop a formal warning system to alert the downstream residents in the event of emergencies. It is also recommended that the owner should take necessary measures to improve the accessibility of the site during high flows.

Lawrence D. Andersen, P.E.
Vice President

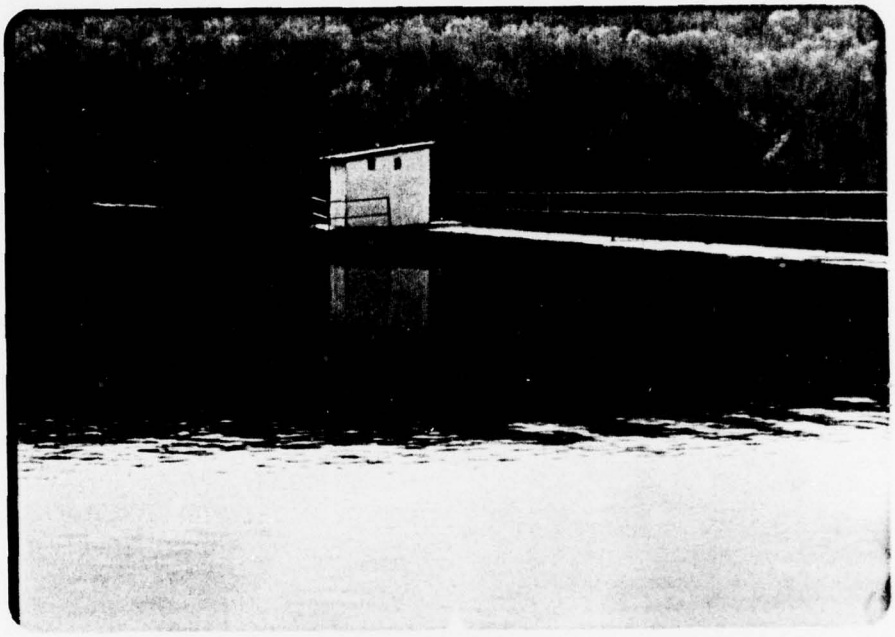
COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
Lawrence D. Andersen
ENGINEER
No. 17458-E

APPROVED BY:

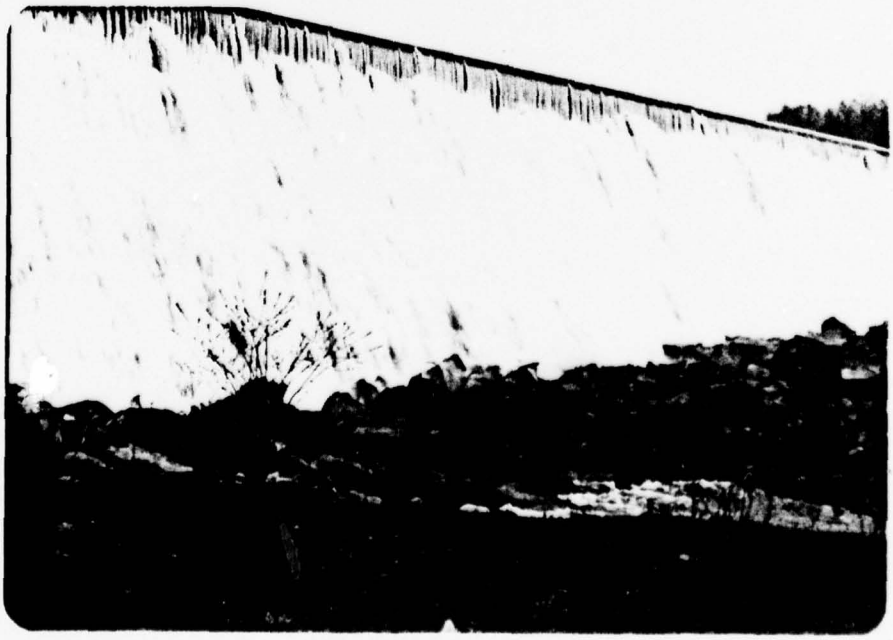
G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE: 6 Jul 78

LLOYDELL DAM
NDS I.D. NO. 500
MAY 18, 1978



Upstream Face



Downstream Face

PHASE I
NATIONAL DAM INSPECTION PROGRAM
LLOYDELL DAM
NDS I.D. NO. 500

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. The dam is a masonry-gravity structure approximately 700 feet long with a maximum height of 43 feet from the downstream toe. (Plates 1 and 2). The single spillway is a 200-foot-long section of the dam which is two feet below the crest of the dam. The flow over the spillway is controlled by a cut stone weir. The spillway discharges down the face of the dam to a riprapped plunge pool. The outlet works consist of a 24-inch cast-iron "blow-off" pipe and a 16-inch cast-iron supply line, both located near the right side of the spillway. Discharge through these pipes is controlled by valves located in the valve house near the toe of the dam. The 24-inch "blow-off" pipe constitutes the emergency drawdown system for the dam. The dam impounds 635 acre-feet of water.

b. Location. Lloydell Dam is located (Plate 3) on the South Fork of Little Conemaugh River, four miles south of the town of Lloydell in Adams Township, Cambria County, Pennsylvania. The impounded reservoir serves as a domestic water supply source.

Downstream from the dam, the South Fork of Little Conemaugh River flows through a narrow and steep uninhabited valley for about four miles and then through the towns of Lloydell and Beaverdale. A distribution reservoir with less than half an acre surface area is located about two miles downstream from the dam. There are approximately 10 houses in the town of Lloydell and 20 houses and two commercial buildings in the town of Beaverdale, which are considered to be the main impact area of a flood. It is estimated that a

failure of the dam would also cause considerable loss of life and property damage along the course of the South Fork of Little Conemaugh River below these towns.

c. Size Classification. Intermediate (based on 43-foot height).

d. Hazard Classification. High.

e. Ownership. Highland Sewer and Water Authority.

f. Purpose of Dam. Water supply.

g. Design and Construction History. Lloydell Dam was designed and constructed by the American Pipe Manufacturing Company. The construction of the dam was completed in 1906.

h. Normal Operating Procedure. The reservoir is maintained at spillway level, Elevation 2386 (USGS Datum), leaving two feet of freeboard to the top of the dam at Elevation 2388. All inflow occurring when the reservoir level is at the spillway crest or above is discharged over the uncontrolled spillway. The supply water is taken from the 16-inch supply line.

1.3 Pertinent Data

a. Drainage Area - 8.0 square miles (Plate 3)

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site - 1.17 feet over spillway in 1936
Warm water outlet at pool elevation - N/A
Diversion tunnel low pool outlet at pool elevation - N/A
Gated spillway capacity at pool elevation - N/A
Gated spillway capacity at maximum pool elevation - N/A
Ungated spillway capacity at maximum pool elevation - 1755
Total spillway capacity at maximum pool elevation - 1755

c. Elevation (USGS Datum)(feet)

Top of dam - 2388
Maximum pool-design surcharge - N/A
Full flood control pond - N/A
Recreation pool - N/A
Spillway crest - 2386
Upstream portal invert diversion tunnel - 2340
Downstream portal invert diversion tunnel - 2335±
Streambed at center line of dam - 2346±
Maximum tailwater - Unknown

d. Reservoir (feet)

Length of maximum pool - 3000
Length of recreation pool - N/A
Length of flood control pool - N/A

e. Storage (acre-feet)

Recreation pool (normal pool) - 635
Flood control pool - N/A
Design surcharge - 84
Top of dam - 719

f. Reservoir Surface (acres)

Top of dam - 42+
Maximum pool - N/A
Flood control pool - N/A
Recreation pool - N/A
Spillway crest - 42

g. Dam

Type - Masonry gravity
Length - 700 feet
Height - 43 feet
Top width - 7 feet
Side slopes - Vertical upstream; 2H:3V downstream
Zoning - N/A
Impervious core - N/A
Cutoff - N/A
Grout curtain - Unknown

h. Diversion and Regulating Tunnel

Type - 24-inch-diameter cast-iron pipe
Length - 200± feet
Closure - Gate valve
Access - At valve house
Regulating Facilities - Gate valve

i. Spillway

Type - Overflow section of dam
Length of weir - 200 feet
Crest elevation - 2386 feet
Gates - None
Upstream channel - Lake
Downstream channel - Natural stream

SECTION 2
ENGINEERING DATA

2.1 Design

a. Data Available

(1) Hydrology and Hydraulics. Review of the information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), showed that there are no original hydrology and hydraulic design data available for the dam. However, a state inspection report entitled, Report Upon the Lloydell Dam, dated October 22, 1914, states the criteria used to size the spillway.

(2) Dam. No design information is available. The 1914 inspection report includes the results of an independent stability analysis.

(3) Appurtenant Structures. No design information is available.

b. Design Features

(1) Dam. As designed, the dam is a "boulder concrete" wall faced with rubble masonry. Plate 1 illustrates the typical cross section of the dam. It consists of an essentially vertical upstream face and a two horizontal to three vertical (2:3) sloping downstream face. The crest is capped with cut stones 7 feet long and 2 feet thick.

The drawings indicate that the dam was founded on rock. A state inspection report entitled, Report Upon the Lloydell Dam, dated October 22, 1914, describes the foundation condition of the dam as follows: "The writer is informed that numerous test pits were made during the preliminary investigations for the foundation and that these test pits were carried down to solid sandstone. The geological formation at the dam site is horizontal strata composed mainly of sandstone and shale, with traces of coal. The dam as constructed was carried down to solid rock throughout its length, it having been extended into the hillsides at each end to that point where the solid rock is at the elevation of the top of the dam. The maximum depth of the excavation below the original ground surface is about 25 feet."

(2) Appurtenant Structures. The spillway is a low section of the dam. The crest of the spillway is capped with rounded hand-cut stones, approximately 7 feet wide and 2 feet thick. The flow from the spillway discharges down the face of the dam to a riprapped plunge pool.

c. Design Data

(1) Hydrology and Hydraulics. The 1914 inspection report states that the spillway of the dam was designed to discharge a flow of 250 cubic feet per second (cfs) per square mile of watershed, for a total flow of 1980 cfs.

(2) Dam. The 1914 report states that the factor of safety of the dam against overturning ranges between 1.61 to 2.21. The higher factor of safety corresponds to the assumption of no hydrostatic pressure at the base of the dam, and the lower factor of safety corresponds to hydrostatic uplift pressure of zero at the downstream toe and two-thirds of the total head at the upstream toe.

(3) Appurtenant Structures. No design data were found relative to the design of appurtenant structures except as stated above.

2.2 Construction. No information was found concerning the construction of the dam other than several photographs taken during construction. The photographs indicate that the dam was founded on rock. The 1914 inspection report states that the construction of the dam was under the direction of Mr. J. W. Ledoux, the Chief Engineer of the American Pipe Manufacturing Company.

2.3 Operation. There are no formal operating records available for this dam. As designed, the dam serves as a water supply reservoir. The supply water from the reservoir discharges through a 16-inch pipe, controlled by valves located in the valve house at the downstream toe of the dam and joins the transmission system.

The 30-inch "blow-off" pipe is also controlled by a valve in the valve house. It discharges directly into the stream.

2.4 Other Investigations. The available information indicated no investigations other than the periodic inspections conducted by the state.

2.5 Evaluation

a. Availability. A very limited amount of engineering data for the dam is available in PennDER files.

b. Adequacy

(1) Hydrology and Hydraulics. Available engineering data are not adequate to assess the structure. Only the design capacity of the spillway is reported.

(2) Dam. Although no original design data are available, the 1914 inspection report states the results of an independent stability analysis which considered the stability of the structure against overturning with and without hydrostatic uplift pressure. Although the reported analysis procedure appears to be satisfactory in general, the calculations were not available for review.

(3) Appurtenant Structures. The flow from the "blow-off" and supply lines through the dam are controlled by valves located at the downstream side of the dam. Therefore, these pipes are always under pressure through the dam. However, this design feature is not considered to be a deficiency for masonry or concrete dams.

c. Operating Records. To the best knowledge of the water company personnel, no operating difficulties have been encountered in the recent past. A state inspection report dated May 14, 1936, states that during the flood in March 1936, the maximum depth of flow over the spillway was 1.17 feet. Although not observed or reported, it appears that the 1977 flow over the spillway may have been higher than the flow in 1936, comparing the intensity of both storms.

d. Post-Construction Changes. There have been no reported significant modifications to the original dam design. However, in 1964, a riser pipe was constructed on the inlet of the supply line.

e. Seismic Stability. The dam is located in Seismic Zone 1 and static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for evaluation of seismic stability of dams, the structure is assumed to present no hazard from earthquake.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Lloydell Dam consisted of:

1. Visual inspection of the retaining structure, abutments, and toe.

2. Visual examination of the spillway and its components, the downstream end of the outlet pipe, and other appurtenant features.

3. Observation of factors affecting the runoff potential of the drainage basin.

4. Evaluation of downstream area hazard potential.

The specific observations are illustrated in Plate 4 and in the photographs in Appendix C.

b. Dam. The general inspection of the retaining structure consisted of searching for indications of structural distress, such as cracks, and deterioration of rock surfaces, seepage areas, and observing general maintenance conditions and other surficial features.

1. The entire downstream face of the dam was found to be wet. Approximately five concentrated seeps were observed through the dam over a distance of approximately 125 feet on the left of the spillway. The discharge from the seeps was estimated to be in the range of 2 to 5 gallons per minute (gpm).

2. Over a distance of approximately 100 feet on the left side of the spillway, the joint mortar on the facing stones was found to be spalled and grass and small trees were growing on the joints.

3. Four coping stones adjacent to the left side of the spillway were cracked and appeared to be loose.

4. A major spring discharging approximately 50 gpm was found on the left abutment approximately 300 feet downstream from the dam at an elevation approximately 3 feet below the dam crest.

5. One concentrated seepage point was found on the right abutment. It was located approximately at the toe level and 100 feet downstream from the dam. The flow was estimated to be 5 to 10 gpm.

6. Numerous grout holes were observed on the crest of the dam. The appearance of the grout material suggests that the grouting was done at various times in the past.

c. Appurtenant Structures. The spillway crests and plunge pools were examined for deterioration or other signs of distress and obstructions that would limit flow. No signs of apparent distress or erosion were observed.

d. Reservoir Area. The watershed is predominantly covered with woodlands and infiltration capacity is estimated to be good. There appeared to be no major land clearing activities or other operations that would significantly increase the runoff rate of the drainage basin.

The shorelines are not considered to be susceptible to massive landslides which would affect the storage volume of the reservoir or cause overtopping of the dam by displaced water.

e. Downstream Channel. The South Fork of Little Conemaugh River flows through a narrow and steep valley before reaching the towns of Lloydell and Beaverdale. Sketches of the bridges over the stream in the first three-mile reach below the dam are included in Appendix A. The two bridges over the stream in the towns of Lloydell and Beaverdale are shown in Photographs 9 and 10, respectively. The downstream channel was described in Section 1.2.

3.2 Evaluation. In general, the condition of the dam is considered to be good. However, repairs to the stone facing joints would be required to avoid further damage due to frost action. Clearing of brush from the face and toe area of the dam is also required to permit adequate continued inspection of the toe area.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedures. A review of the design drawings and field observations indicates that there are no formal procedures for operating the dam. The only operational feature of the dam which may affect the safety of the dam is the outlet pipe valve, in case it is required to lower the reservoir.

The clearing of debris from the spillway and removal of the brush from the downstream face and toe area as it is required and continued inspection of the facilities by the dam tender are the principal maintenance operations which would affect safety.

4.2 Maintenance of the Dam. The overall maintenance conditions of the dam are considered to be fair. Removal of the brush from the downstream toe area would be required to facilitate adequate inspection of the toe area.

4.3 Maintenance of Operating Facilities. On the date of the field inspection, the "blow-off" pipe was operated by water company personnel and was observed to be functional.

4.4 Warning System in Effect. There is no formal flood warning system in effect. The dam tender resides in Johnstown, approximately 15 miles from the dam site. Water company personnel reported that the dam tender visits the dam daily. However, the dam site is not accessible during periods of high stream flow. No communication facilities are available at the dam site.

4.5 Evaluation. The maintenance condition of the dam is considered to be fair. The dam is not accessible under all weather conditions for inspection and emergency action purposes. The access road is located on the flood plain of the stream. The main stream and several tributaries of the South Fork of Little Conemaugh River flow over the access road at various locations.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features. No formal hydrology and hydraulic calculations are available for this dam.

a. Design Data. Lloydell Dam has a watershed area of 8.0 square miles and impounds a reservoir with a surface area of 41 acres. A 200-foot-wide spillway flowing over the dam constitutes the flood discharge system for the impoundment. The flow through the spillway is controlled by a stone weir at an elevation two feet below the crest of the dam. As it presently exists, the spillway has a maximum discharge capacity of approximately 1750 cfs with no freeboard.

b. Experience Data. As previously stated, Lloydell Dam is classified to be an "intermediate" size dam in the "high" hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass the probable maximum flood (PMF).

The adequacy of the spillway was analyzed based on the simplified procedure developed by the Baltimore District, Corps of Engineers (Appendix D). Based on this analysis procedure, it was determined that the PMF inflow hydrograph would have a peak of 12,800 cfs and a total volume of approximately 11,000 acre-feet. These values are greater than the spillway capacity (1750 cfs) and the reservoir flood storage volume (84 acre-feet). Therefore, the spillway is not capable of passing the PMF flow without overtopping. Further analysis, according to the procedure, indicated that the spillway can pass a maximum flow of approximately 14 percent of the PMF without overtopping. In the event of full PMF, the depth of overtopping over the entire dam was determined to be approximately 2.6 feet.

c. Visual Observations. On the date of inspection, no conditions were observed which would indicate that the spillway of the dam could not operate satisfactorily in the event of a flood.

d. Overtopping Potential. As stated above, the dam will be overtopped during a flood whose magnitude exceeds 14 percent PMF. However, because it is a masonry dam, overtopping is not considered to significantly affect the overall stability of the dam.

e. Spillway Adequacy. Based on the observations stated above, flood discharge capacity of the dam is considered to be adequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the stability of the dam and none were reported in the past.

b. Design and Construction Data. It appears that the original design incorporated stability analyses for the dam. Visual observations and past inspection reports indicate that the structure was constructed with reasonable care.

As a part of this inspection, the stability of the dam was reevaluated by an independent preliminary analysis. The preliminary stability analysis indicated that the factor of safety against overturning is 1.5 when pool level is at the crest level of the dam and 1.3 when the dam is overtopped by 2.6 feet. Sliding shear stresses for the two loading conditions were determined to be 19 and 22 psi, respectively. The sliding shear stresses are within the range of allowable shear strength of sandstones typical to the area on which the dam is reported to be founded. This analysis indicates that the dam is stable, concurring with the results of an analysis noted in the 1914 inspection report.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. There have been no reported modifications to the original design that would affect the structural stability of the structure.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety. The visual observations and review of available information indicate that Lloydell Dam is in good condition. It appears that the structure was built and has been maintained with reasonable care with the means available at the time of construction. The capacity of the spillway was found to be inadequate (16 percent PMF) relative to the spillway capacity criteria established by the Corps of Engineers. However, because an overtopping would not cause failure of the dam, flood discharge capacity of the dam was considered to be adequate.

b. Adequacy of Information. Although the available design information is very limited, a reasonable assessment of the dam can be made on visual observations, reports of past observations, and previous experience of the inspectors.

c. Urgency. It is considered that the recommendations suggested below be implemented on a continuing basis.

d. Necessity for Further Investigation. The condition of the dam does not require more detailed investigation at this time.

7.2 Recommendations/Remedial Measures

1. Since the dam may overtop during unusually high runoff, it is recommended that during such periods the owner should provide around-the-clock surveillance for early detection of problems, such as erosion of the abutments. It is also recommended the owner should take necessary measures to improve the accessibility of the site during high flow conditions.

2. It is recommended that as soon as practicable appropriate repairs be undertaken to correct the joint mortar spalling and seepage condition on the face of the dam. Also, trees and brush should be removed from the face of the dam.

3. It is recommended that brush and trees in the toe area should be cleared over a distance of approximately 50 feet from the toe to permit adequate future inspection of the toe area.

4. It is recommended that the owner should develop a formal warning system to alert the downstream residents in the event of emergencies.

5. It is recommended that the owner be advised that the dam and appurtenant structures should be inspected regularly by the dam tender and any unusual condition should be reported to the appropriate authorities.

PLATES

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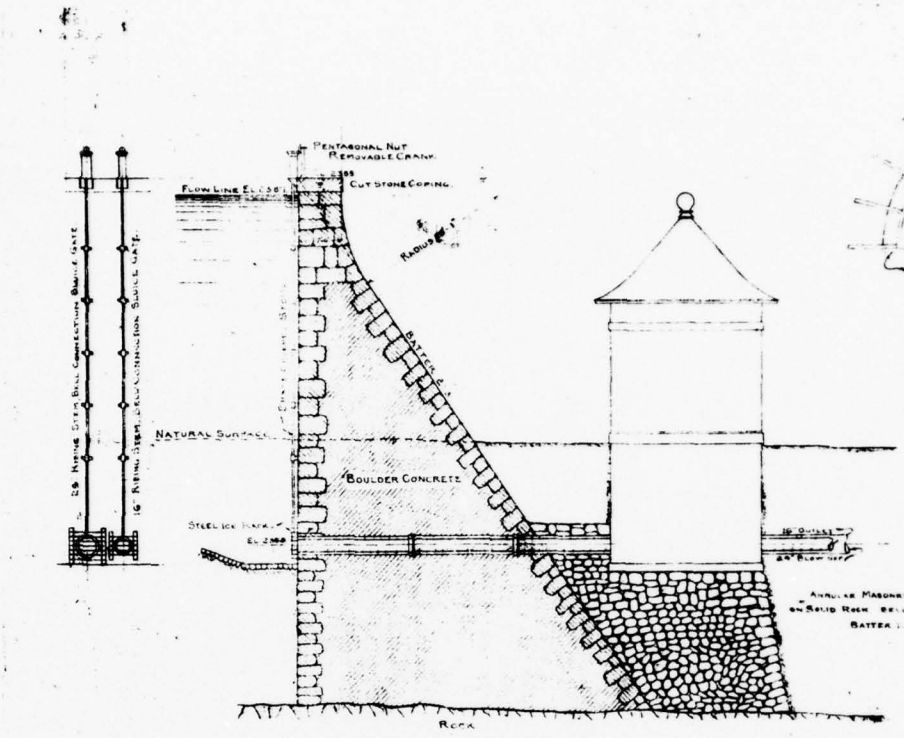
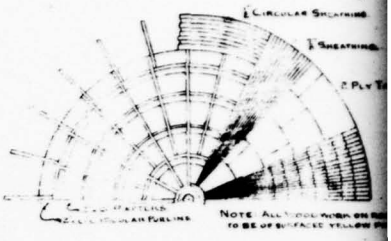
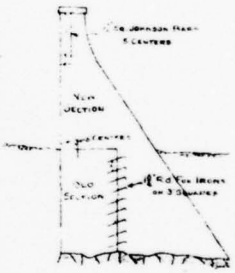
	5-31-78	APPROVED BY	JHD	6/2/78	

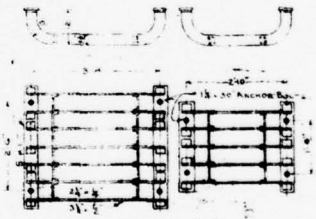


SECTION OF DAM AT GATE HOUSE.



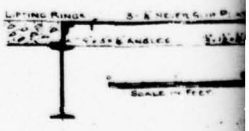


REINFORCEMENT IN DAM

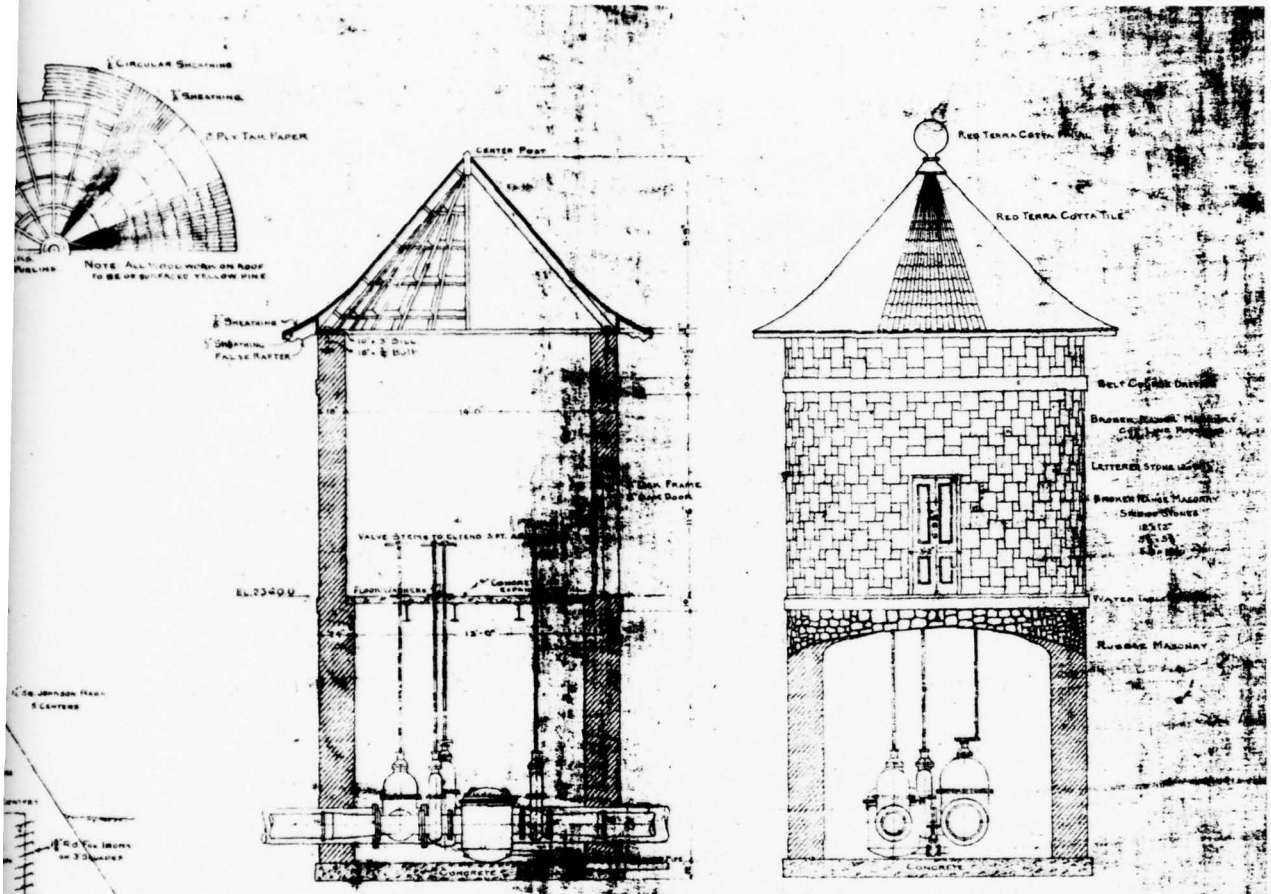


STEEL ICE RACKS

SECTION OF DAM THROUGH SPILLWAY.



SECTION A-



DETAILS OF GATE HOUSE.

SUMMIT WATER SUPPLY CO.

STORAGE RESERVOIR.

LLOYDELL DAM.

CAPACITY 207 000 000 GALS.

THE AMERICAN PIPE MFG. CO.

ENGINEERS AND CONTRACTORS

SECTION A-A.

Revised as Constructed

PLATE I

D'APPOLONIA

2

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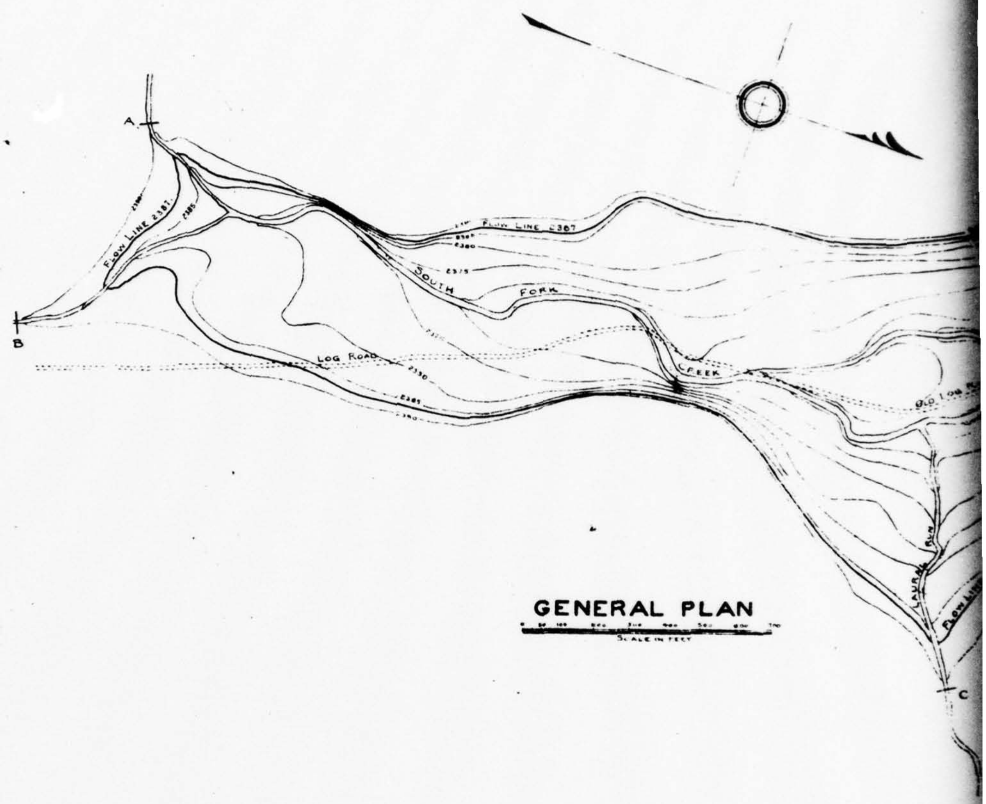
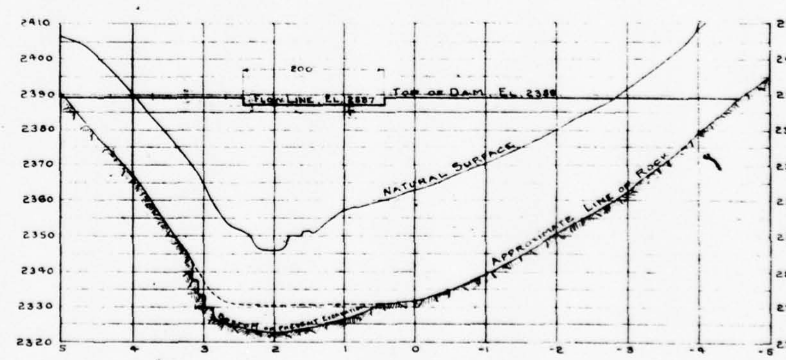


GENERAL PLAN

SCALE IN FEET



PROFILE

HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET

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FOR EACH

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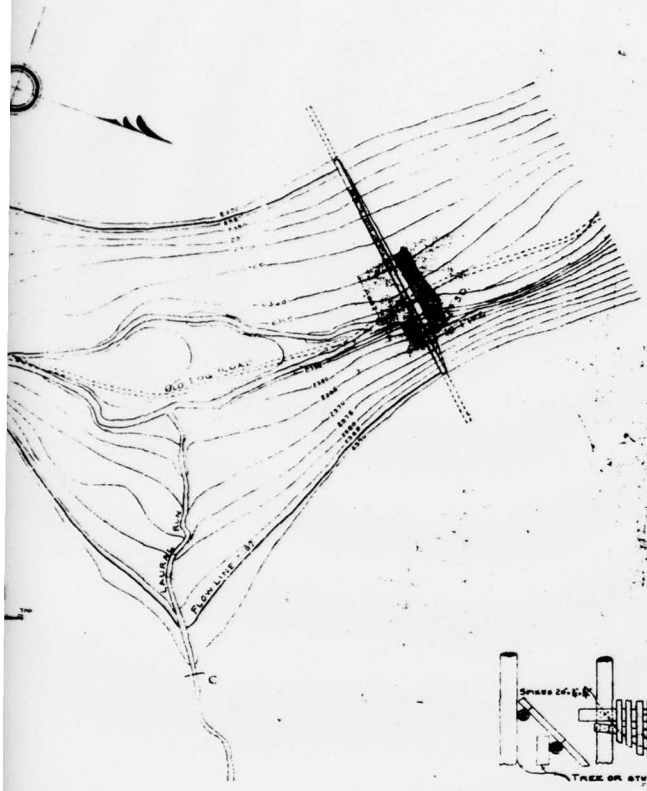
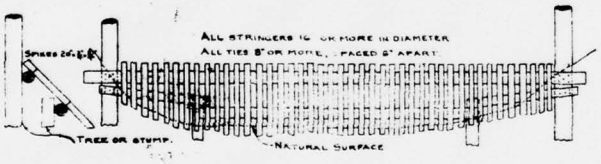




FLOOD-WOOD RACK.
AT A, B & C.

CAPACITY
FOR EACH FOOT IN ELEVATION

2387	207 000 000	GALS
2386	193 [illegible] 000	
2385	180 200 000	
2384	168 [illegible] 000	
2383	156 300 000	
2382	144 700 000	"
2381	133 [illegible] 000	
2380	122 600 000	"
2379	112 [illegible] 000	
2378	102 400 000	"
2377	93 800 000	"
2376	85 400 000	"
2375	78 [illegible] 000	"
2374	71 [illegible] 000	"
2373	65 [illegible] 000	"
2372	59 100 000	"
2371	53 [illegible] 000	"
2370	48 [illegible] 000	"
2369	43 [illegible] 000	"
2368	38 400 000	"
2367	34 [illegible] 000	"
2366	30 [illegible] 000	"
2365	26 [illegible] 000	"
2364	23 [illegible] 000	"
2363	20 000 000	"
2362	17 [illegible] 000	"
2361	15 [illegible] 000	"
2360	13 200 000	"
2359	11 [illegible] 000	"
2358	9 400 000	"
2357	8 [illegible] 000	"
2356	7 [illegible] 000	"
2355	6 [illegible] 000	"
2354	5 [illegible] 000	"
2353	4 [illegible] 000	"
2352	3 [illegible] 000	"
2351	2 [illegible] 000	"
2350	1 [illegible] 000	"
2349	900 000	"
2348	800 000	"
2347	700 000	"
2346	600 000	"
2345	500 000	"
2344	400 000	"
2343	300 000	"
2342	200 000	"
2341	100 000	"
2340	000 000	"

SUMMIT WATER SUPPLY CO.
STORAGE RESERVOIRS
LLOYDELL DAM.
CAPACITY 207 000 000 GALS.

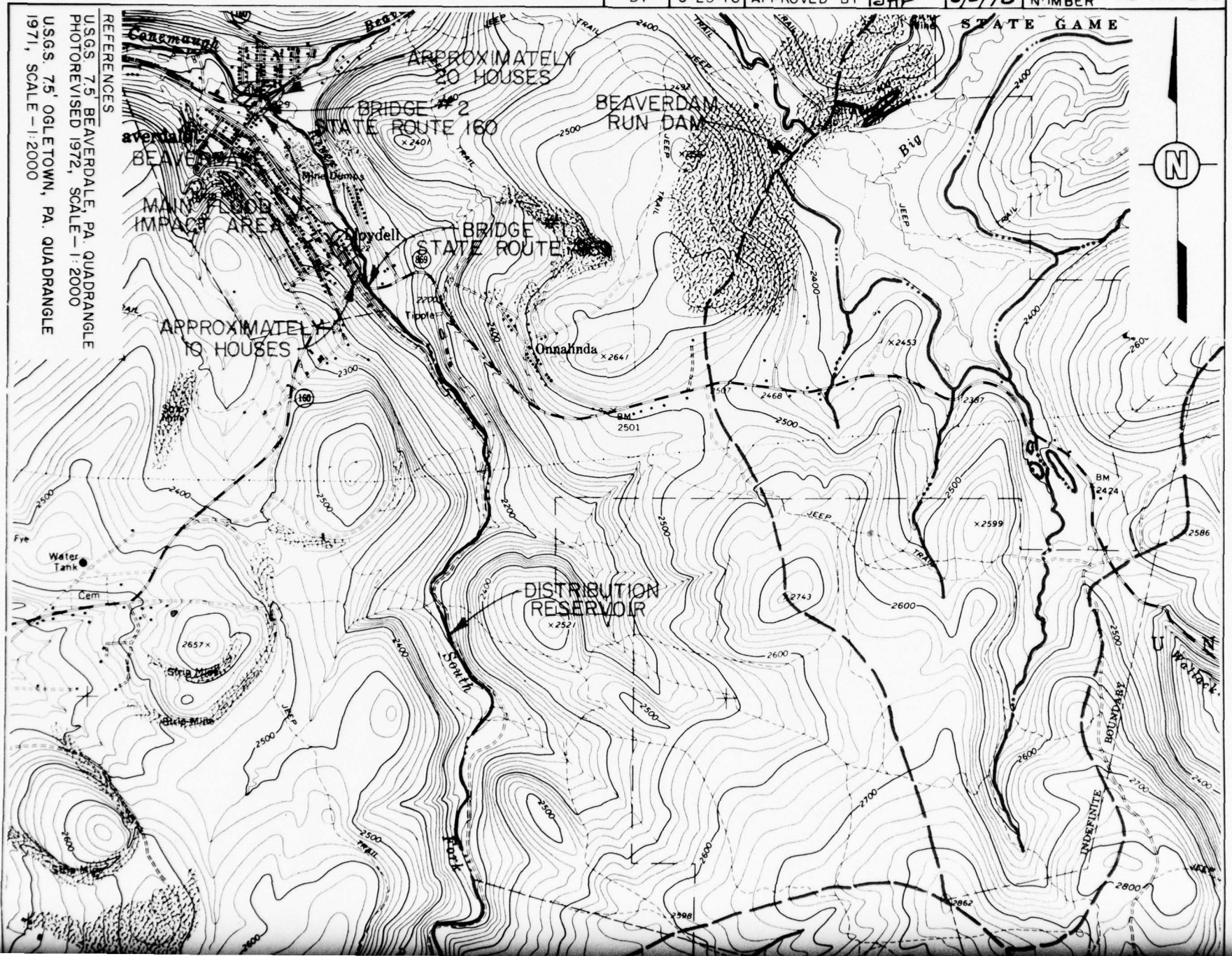
THE AMERICAN PIPE MFG CO.
ENGINEERS AND CONTRACTORS
118 N. BROAD ST. PHILA. PA.

APPROVED [signature] 1911
APPROVED [signature]

PLATE 2

D'APPOLONIA 2

DRAWN BY	RGN 5-25-78	CHECKED BY JHP	BE 6-2-78 6/2/78	DRAWING NUMBER 78-114-B46



REFERENCES

USGS 7.5 BEAVERDALE, PA. QUADRANGLE PHOTOREVISED 1972, SCALE – 1:2000

USGS 75' OGLETOWN, PA. QUADRANGLE 1971, SCALE – 1:2000

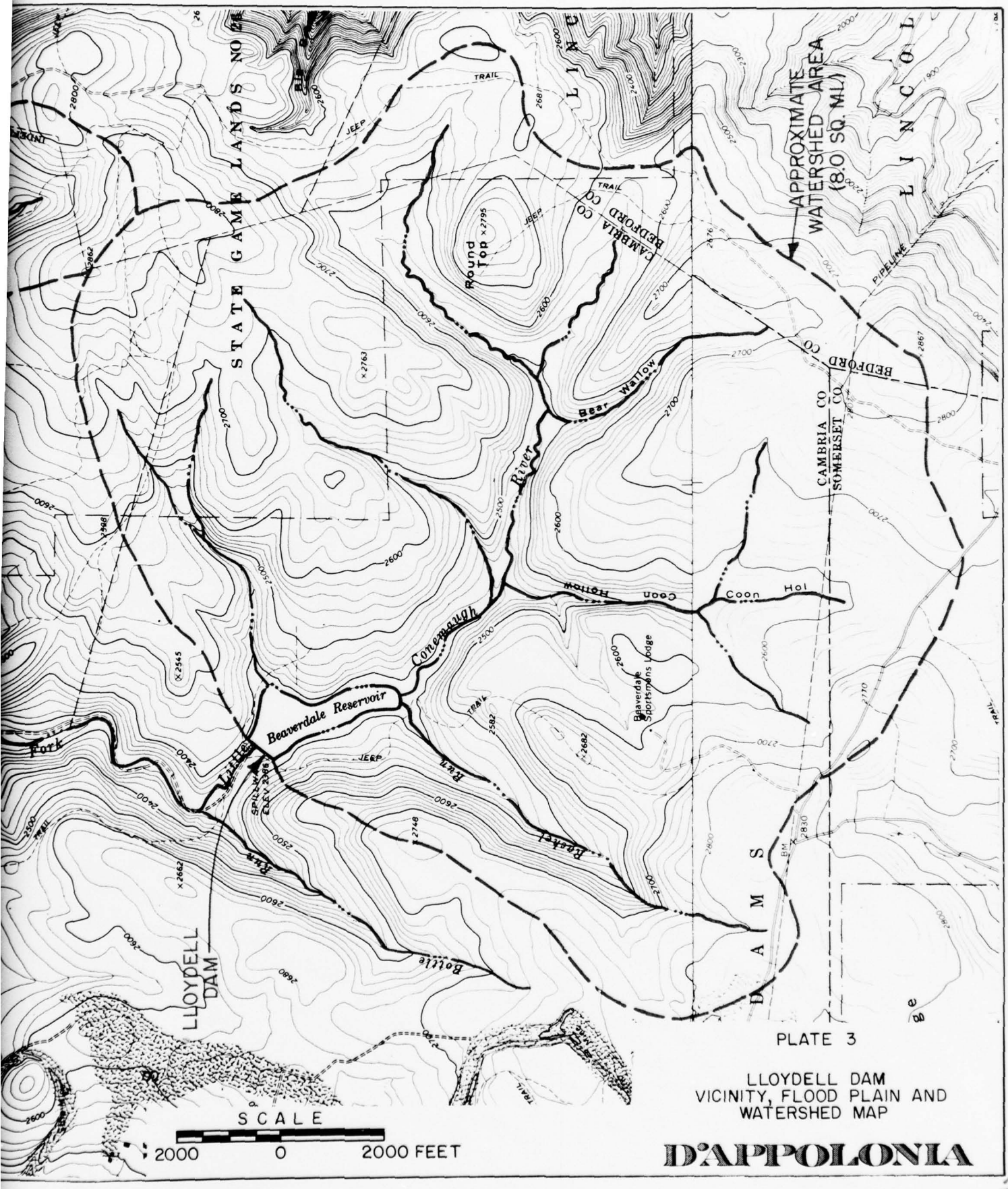
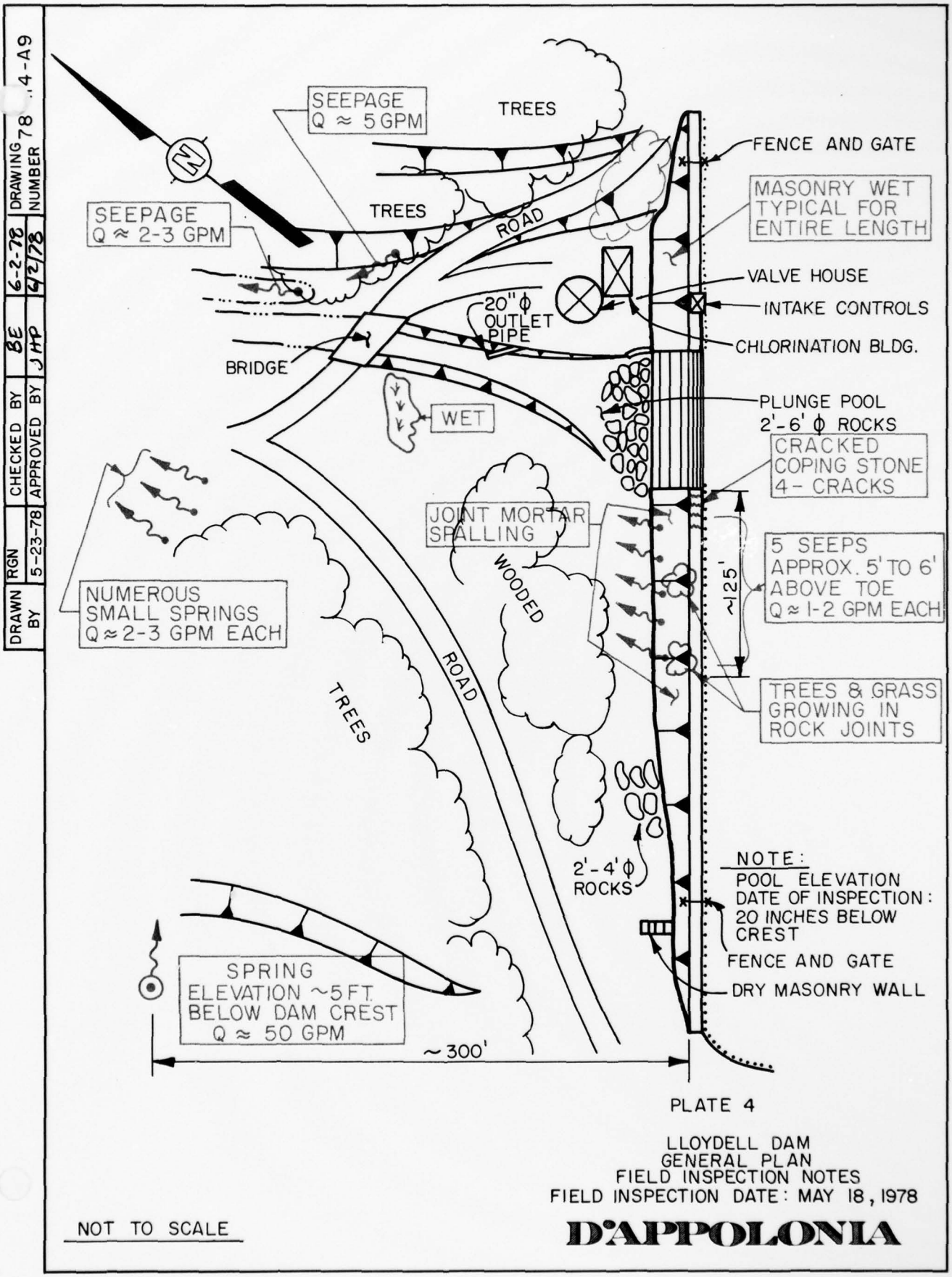


PLATE 3

LLOYDELL DAM
VICINITY, FLOOD PLAIN AND
WATERSHED MAP

D'APPOLONIA

2


DRAWN BY
RGN
5-23-78
CHECKED BY
BE
6-2-78
APPROVED BY
JHP
6/2/78
DRAWING NUMBER
78-A9
SEEPAGE
Q ≈ 5 GPM
TREES
FENCE AND GATE
MASONRY WET
TYPICAL FOR
ENTIRE LENGTH
SEEPAGE
Q ≈ 2-3 GPM
TREES
ROAD
VALVE HOUSE
INTAKE CONTROLS
20" ϕ
OUTLET
PIPE
CHLORINATION BLDG.
BRIDGE
WET
PLUNGE POOL
2'-6' ϕ ROCKS
CRACKED
COPING STONE
4 - CRACKS
JOINT MORTAR
SPALLING
5 SEEPS
APPROX. 5' TO 6'
ABOVE TOE
Q ≈ 1-2 GPM EACH
~125'
WOODED
NUMEROUS
SMALL SPRINGS
Q ≈ 2-3 GPM EACH
TREES
ROAD
TREES & GRASS
GROWING IN
ROCK JOINTS
2'-4' ϕ
ROCKS
NOTE:
POOL ELEVATION
DATE OF INSPECTION:
20 INCHES BELOW
CREST
FENCE AND GATE
DRY MASONRY WALL
SPRING
ELEVATION ~5 FT.
BELOW DAM CREST
Q ≈ 50 GPM
~300'
PLATE 4
LLOYDELL DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: MAY 18, 1978
NOT TO SCALE
D'APPOLONIA

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM LLOYDELL DAM COUNTY CAMBRIA STATE PA ID# NDS:500 DER:11-5

TYPE OF DAM MASONRY HAZARD CATEGORY HIGH.

DATE(S) INSPECTION MAY 18, 1978 WEATHER RAINY TEMPERATURE 50's

POOL ELEVATION AT TIME OF INSPECTION 2386.2' M.S.L. TAILWATER AT TIME OF INSPECTION ~2346 M.S.L. (ESTIMATED)

INSPECTION PERSONNEL:

BILGIN EREL
WAH-TAK CHAN

REVIEW FIELD INSPECTION: (MAY 30, 1978)

ELIO D'APPOLONIA.
LAWRENCE ANDERSEN
JAMES POELLOT.

BILGIN EREL RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	MASONRY DAM ∴ N/A.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	N/A.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	N/A.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	N/A	
RIPRAP FAILURES	N/A	

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER: 11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	MASONRY DAM ∴ N/A.	
ANY NOTICEABLE SEEPAGE	N/A.	
STAFF GAGE AND RECORDER	N/A	
DRAINS	N/A	
	N/A	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	5 CONCENTRATED SEEPS OVER ~125 FT LEFT OF SPILLWAY Q ≈ 1-2 GPM/EACH	SEE PLATE 4
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	NO VISUAL SIGNS OF DISTRESS. NO SEEPAGE	
DRAINS	NONE FOUND	
WATER PASSAGES	NONE	
FOUNDATION	NO PERCEIVABLE SIGN OF DISTRESS.	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	4 - CRACKS ON THE CREST CAPPING STONE (LEFT OF SPILLWAY)	SEE PLATE 4 FOR LOCATION.
STRUCTURAL CRACKING	NONE FOUND	
VERTICAL AND HORIZONTAL ALIGNMENT	NO PERCEIVABLE MISALIGNEMENT.	
MONOLITH JOINTS	MASONRY DAM ∴ N/A.	
CONSTRUCTION JOINTS STAFF GAGE OF RECORDER:	(NO CONSTRUCTION JOINTS) NONE FOUND.	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

NAME OF DAM LLOYDELL DAM
ID# NDS: 500 DER: 11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	OUTLET CONDUIT IS CAST IRON.	
INTAKE STRUCTURE	SUBMERGED NOT VISIBLE.	
OUTLET STRUCTURE	NO OUTLET STRUCTURE. OUTLET PIPE IS DIRECTLY DISCHARGING INTO THE STREAM	
OUTLET CHANNEL	NO OUTLET CHANNEL.	
EMERGENCY GATE	GATE ON 24-INCH BLOW-OFF PIPE VALVE OPERATED BY WATER COMPANY PERSONNEL FOUND TO BE FUNCTIONAL	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

NAME OF DAM LLOYDELL DAM
ID# NDS: 500 DER: 11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	STONE WEIR GOOD CONDITION.	
APPROACH CHANNEL	NONE. SPILLWAY IS LOCATED AT THE MIDDLE OF THE DAM.	
DISCHARGE CHANNEL	NONE. SPILLWAY DISCHARGES OVER THE DAM, INTO A PIPRAPPED PLUNGE POOL.	
BRIDGE AND PIERS	NONE	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

NAME OF DAM LLOYDELL DAM
ID# NDS: 500 DER: 11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	NONE	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

NAME OF DAM LLOYDELL DAM

ID# NDS: 500, DER: 11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE FOUND	
OBSERVATION WELLS	NONE FOUND.	
WEIRS	NONE FOUND.	
PIEZOMETERS	NONE FOUND.	
OTHER		

VISUAL INSPECTION
PHASE I
RESERVOIR

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	GENTLE TO STEEP, WOODED	
SEDIMENTATION	LAKE WATER WAS CLEAR NO INDICATION OF HIGH RATE OF SEDIMENTATION.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

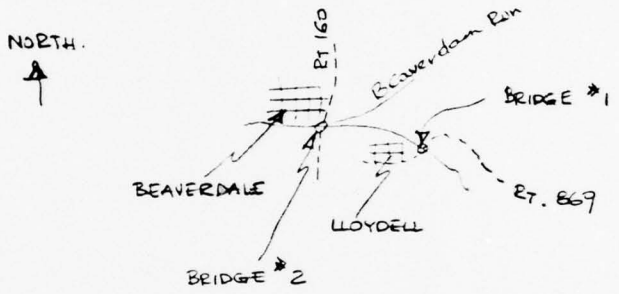
NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	TYPICAL MOUNTAIN STREAM	SEE SKETCHES IN APPENDIX-A FOR SKETCHES OF BRIDGES OVER THE STREAM.
SLOPES	NO MAJOR EROSION	
APPROXIMATE NUMBER OF HOMES AND POPULATION	TOWNS OF LLOYDELL & BEAVERDALE. MAIN IMPACT AREA OF FLOOD: LLOYDELL: 10 HOMES BEAVERDALE: 20 HOMES 2 COMMERCIAL BUILDINGS. POPULATION ≈ 100	ADDITIONAL LIFE LOSS AND PROPERTY DAMAGE MAY OCCUR ALONG THE SOUTH FORK LITTLE CONEMAUGH BELOW BEAVERDALE.

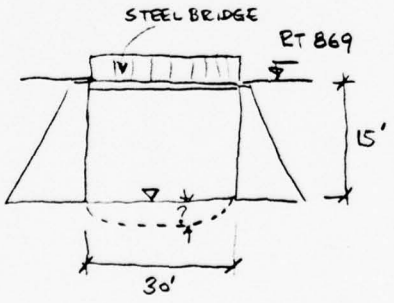
D'APPOLONIA
CONSULTING ENGINEERS, INC

By BE Date 5-18-78 Subject LLOYDELL DAM NDS:500 Sheet No. 1 of 1
Chkd. By WTC Date 5-18-78 FIELD INSPECTION SKETCH. Proj. No. 78-114-12

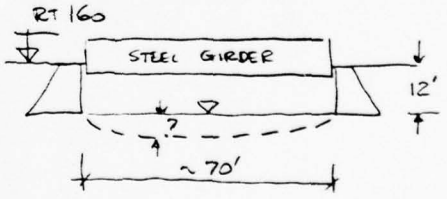
STREAM CROSS SECTION & BRIDGE CROSSINGS:-
(IMMEDIATE DAMAGE REACH)



BRIDGE #1



BRIDGE #2



APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER 11-5

ITEM	REMARKS
AS-BUILT DRAWINGS	SOME DESIGN DRAWINGS AVAILABLE (NOT MARKED AS-BUILT) SEE PLATES 1 & 2
REGIONAL VICINITY MAP	SEE PLATE -3
CONSTRUCTION HISTORY	BUILT ON 1906. HISTORY OF CONSTRUCTION PARTIALLY DOCUMENTED IN 1914 STATE INSPECTION REPORT.
TYPICAL SECTIONS OF DAM	SEE PLATE - 1
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATING	SEE PLATE - 1 - NOT REPORTED.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM LLOYDELL DAM
ID# NDS:500, DER 11-5

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE FOUND
DESIGN REPORTS	NONE FOUND.
GEOLOGY REPORTS	NONE FOUND. A BRIEF DESCRIPTION OF SUBSURFACE CONDITIONS ARE INCLUDED IN A 1914 STATE INSPECTION REPORT.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	NONE FOUND. THE 1914 INSPECTION REPORT INCLUDES THE RESULT OF AN INDEPENDENT STABILITY ANALYSIS.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	NONE FOUND.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	NONE .
BORROW SOURCES	UNKNOWN
MONITORING SYSTEMS	NONE
MODIFICATIONS	A RISER PIPE WAS INSTALLED TO THE SUPPLY MAIN.
HIGH POOL RECORDS	NOT AVAILABLE.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM LLOYDELL DAM
ID# NDS:500 DER:11-5

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	NONE OTHER THAN THE PERIODIC INSPECTIONS CONDUCTED BY THE STATE.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	NONE FOUND.
MAINTENANCE OPERATION RECORDS	NOT AVAILABLE.
SPILLWAY PLAN SECTIONS DETAILS	SEE PLATE 2 SEE PLATE 1
OPERATING EQUIPMENT PLANS AND DETAILS	SEE PLATE - 1 (24-INCH CAST IRON PIPE)

NAME OF DAM LLOYDELL DAM

ID# NDS: 500 DER: 11-5

CHECKLIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: WOODED (8.0 SQ. MILES)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 635 ACRE-FEET)

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: SAME AS ABOVE

ELEVATION; MAXIMUM DESIGN POOL: 2386 (AS DESIGNED) USGS DATUM

ELEVATION; TOP DAM: 2388 (AS DESIGNED) USGS DATUM

CREST:

a. Elevation 2388 FT

b. Type CUT STONE

c. Width 7 FEET

d. Length 700 FEET

e. Location Spillover NO VISUALLY IDENTIFIABLE LOW SECTIONS

f. Number and Type of Gates NONE

OUTLET WORKS:

a. Type 24-INCH CAST IRON BLOW-OFF PIPE.

b. Location RIGHT OF SPILLWAY

c. Entrance Inverts 2340 FT

d. Exit Inverts 2335 FT (ESTIMATED)

e. Emergency Draindown Facilities 24-INCH BLOW-OFF PIPE

HYDROMETEOROLOGICAL GAGES:

a. Type NONE

b. Location NONE

c. Records NONE.

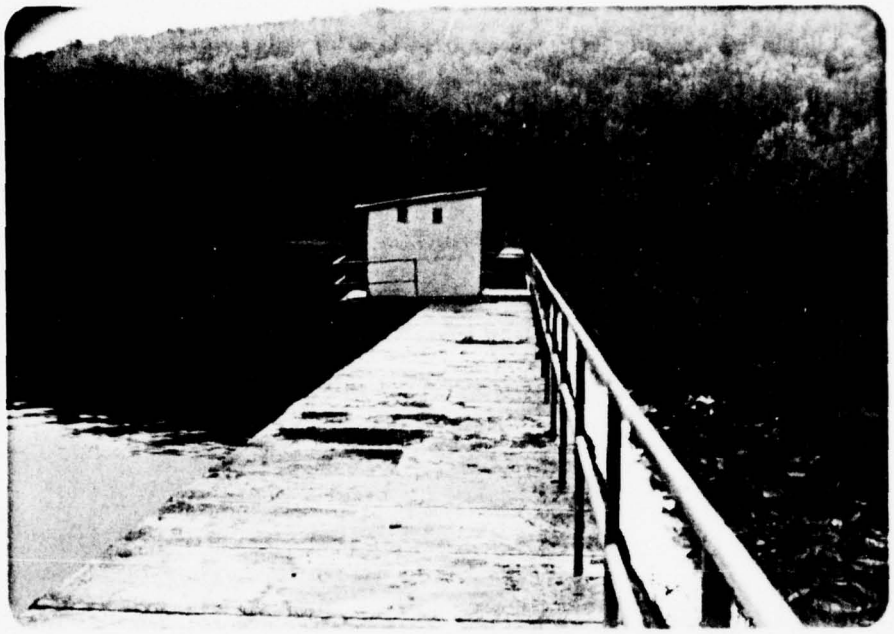
MAXIMUM NONDAMAGING DISCHARGE:

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
LLOYDELL DAM
NDS I.D. NO. 500
MAY 18, 1978

PHOTOGRAPH NO.	DESCRIPTION
1	Dam crest.
2	Downstream slope.
3	Right abutment.
4	Spillway, plunge pool, and spillway discharge channel.
5	Cracks in capping stone (left of spillway).
6	Seepage through joints on downstream slope.
7	Seepage at right abutment.
8	Distribution pond located 2 miles downstream.
9	Bridge No. 1.
10	Bridge No. 2.

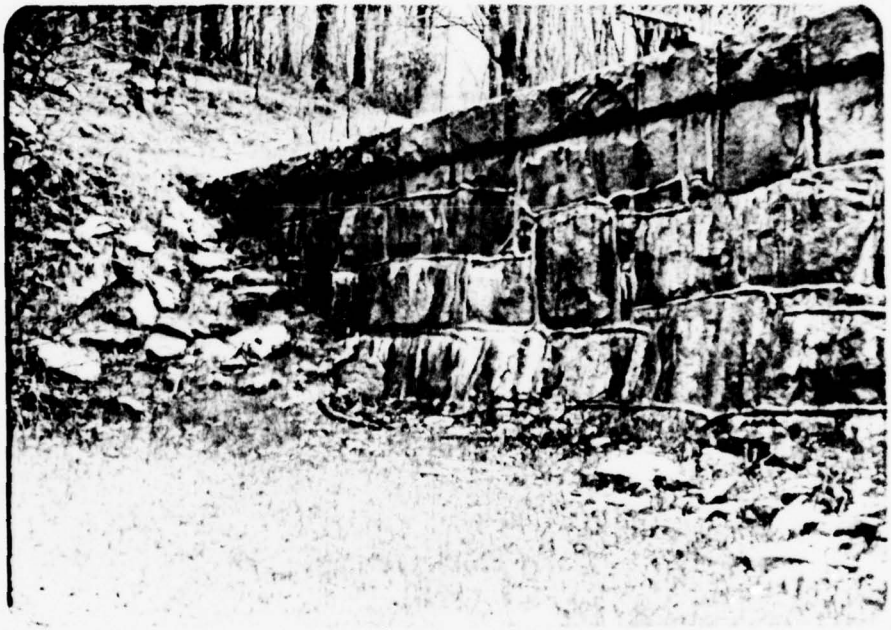


Photograph No. 1

Dam crest.

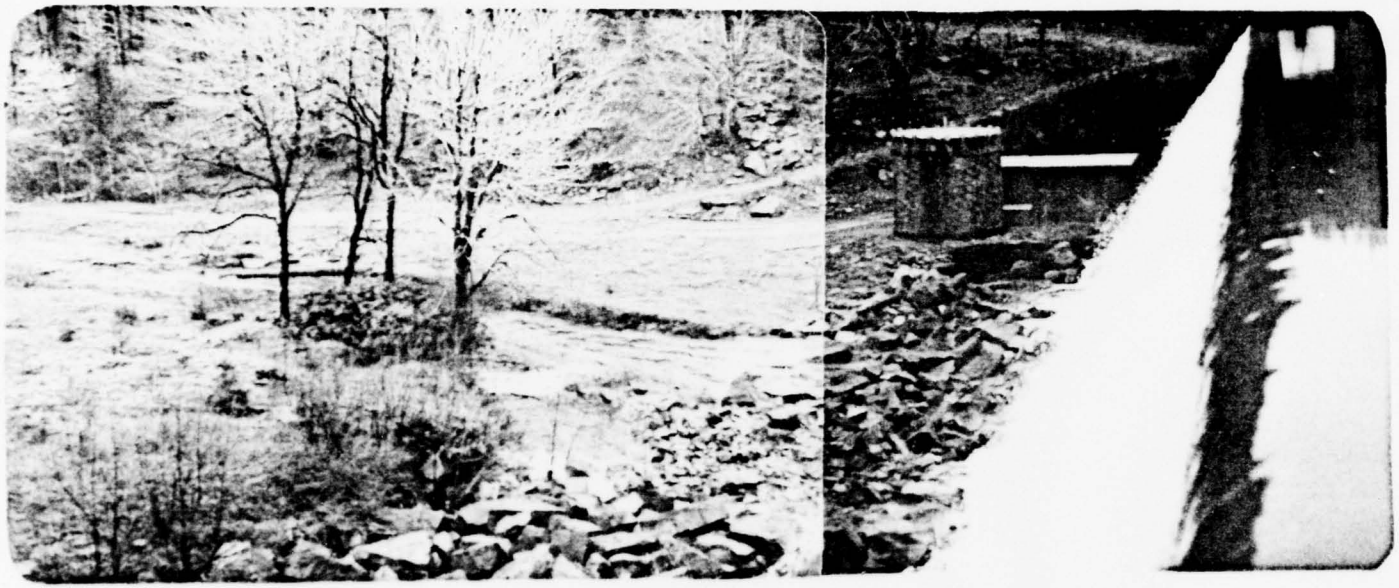
Photograph No. 2

Downstream slope.



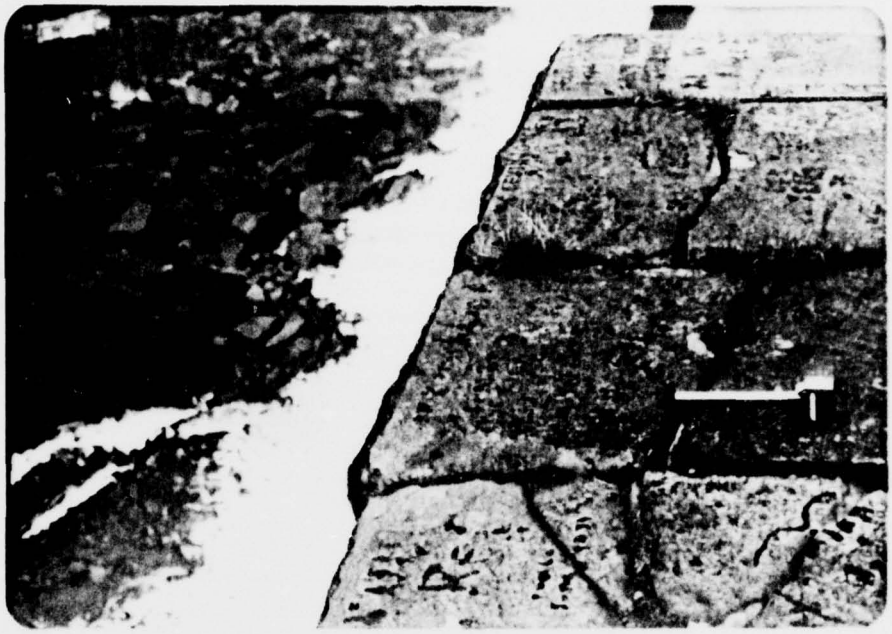
Photograph No. 3

Right abutment.



Photograph No. 4

Spillway, plunge pool, and spillway discharge channel.



Photograph No. 5

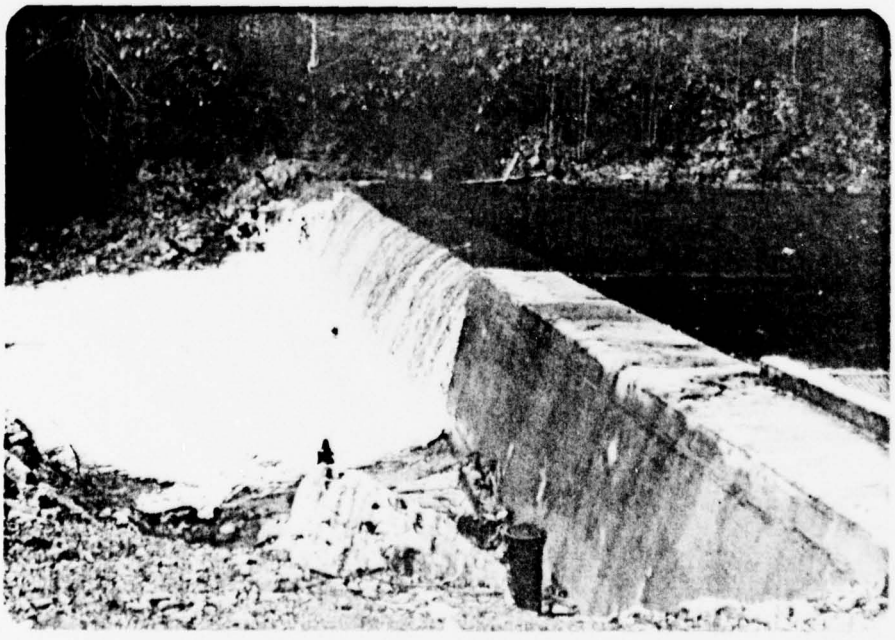
Cracks in capping stone (left of spillway).

Photograph No. 6

Seepage through joints on downstream slope.

Photograph No. 7

Seepage at right abutment.

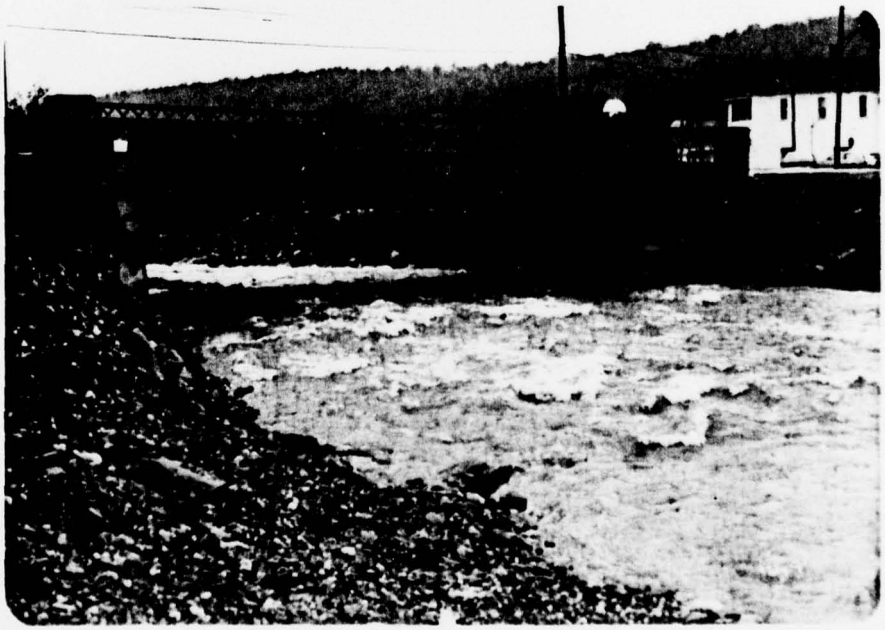


Photograph No. 8

Distribution pond located 2 miles downstream.

Photograph No. 9

Bridge No. 1.



Photograph No. 10

Bridge No. 2.

APPENDIX D

CALCULATIONS

DiAPPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 6-20-78 Subject LLOYDELL DAM NDS-500 Sheet No. 1 of 3
Chkd. By RE Date 6-20-78 HYDROLOGY & HYDRAULIC Proj. No. 78-114-2

DAM: LLOYDELL DAM NDS-500

WATERSHED AREA, A_1 = 8 SQ MI

INFLOW HYDROGRAPH: BASIN – OHIO RIVER BASIN, SOUTH FORK OF THE LITTLE CONEMAUGH RIVER IN ADAMS TOWNSHIP CAMBRIA COUNTY, PA

TOTAL TIME = T = 44 HOURS

PMF Peak Flow q = 1600 cfs } FROM CHART PROVIDED BY BALTIMORE DISTRICT

$Q = qA$ = 12800 cfs

VOLUME OF INFLOW

$V_i = \frac{1}{2}(T \times 3600) \times Q \times \frac{1}{43560}$ ac-ft

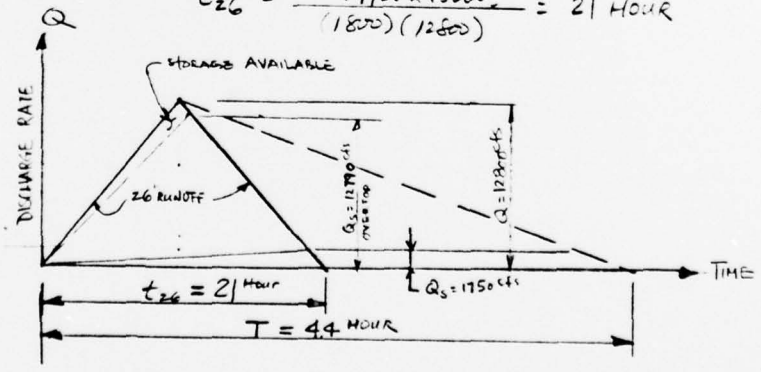
= 23272 AC-FT

EQUAL TO 54.6"/44 HOUR RUNOFF, ~~USE~~ High

USE 26" RUNOFF RECALC t_{26}

$V_{26} = (\frac{26}{12})(8)(5280)^2 \frac{1}{43560}$ = 11170 AC-FT SAY 11,000

$t_{26} = \frac{11000 \times 43560}{(1800)(12800)}$ = 21 HOUR



D'APPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 6-20-78 Subject LLOYDELL DAM NDS-500 Sheet No 2 of 3
Chkd. By BE Date 6-20-78 HYDROLOGY & HYDRAULIC Proj. No 78-114-12

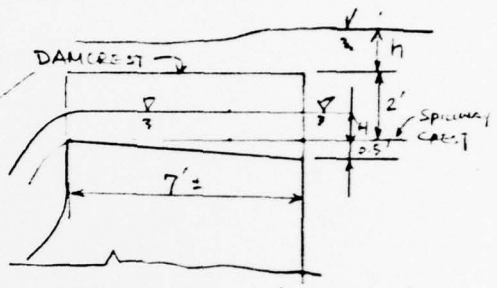
SPILLWAY CAPACITY

TYPE: WEIR AS SHOW

L = 200' HEAD = 2'

$Q_S = (3.1)(200)(2)^{1.5}$

$= 1754^{cfs}$



C = 3.5 was used in Original Design Work

ACTUALLY THE WHOLE DAM CREST IS LIKE A WEIR

TOTAL $Q_S = (3.1)(200)(h+2)^{1.5} + (3.1)(500)(h)^{1.5}$

$= 620(h+2)^{1.5} + 1550\, h^{1.5}$

RESERVOIR STORAGE Volume

$V_R = 42^{ACRE}$ (NORMAL POOL) $\times 2^{FT}$

$= 84^{ac-ft}$

OR $V_R = 42 \times (2+h)$ ac-ft

REQ'D RESERVOIR CAPACITY TO PASS PMF

$V'_{Req'd} = \left(1 - \frac{\text{MAX spillway}}{\text{Peak flow}}\right)(\text{Vol of inflow})$

$= \left(1 - \frac{1754}{12800}\right)(11100)$

$= 9579^{ac-ft} >> 84^{ac-ft}$

THE CREST WILL BE OVERTOPPED

D'APPOLONIA
CONSULTING ENGINEERS INC

By WTC Date 6-20-78 Subject LLOYDELL DAM NDS 502 Sheet No 3 of 3
Chkd. By EE Date 6-20-78 HYDROLOGY & HYDRAULICS Proj. No 78-114-12

DETERMINE WATER DEPTH h of 26" RUNOFF STORM OVER DAM CREST

$$\frac{620\,(h+2)^{1.5}}{12800} + \frac{1550h^{1.5}}{11100} + \frac{42(h+2)}{11100} = 1$$

$$h = 2.63 \text{ FT}$$

$$Q_s = 12790 \text{ cfs}$$

PERCENT OF PMF (26" RUNOFF) WITHOUT OVERTOPPING

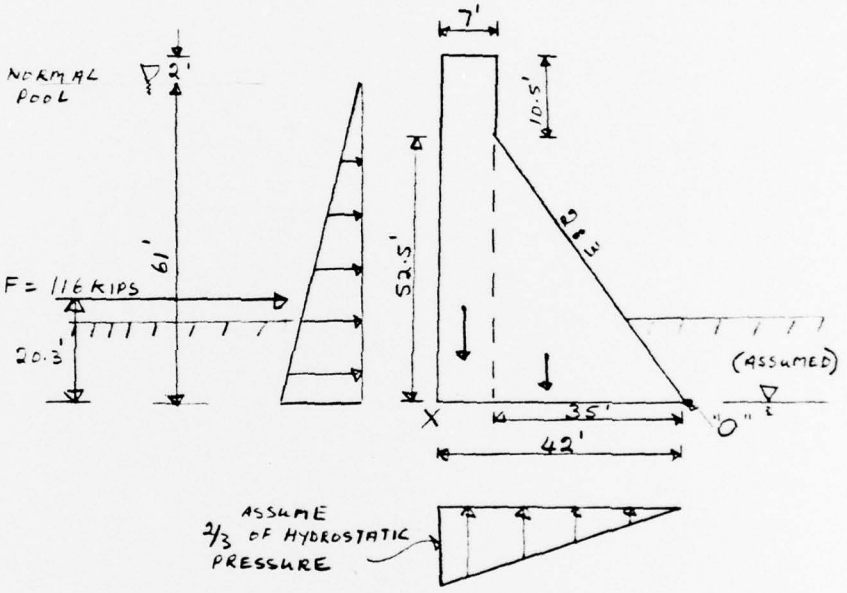
$$= \left(\frac{1780}{12,800} + \frac{84}{11,100}\right) \times 100 = 14.4\ \%$$

D'APPOLONIA
CONSULTING ENGINEERS, INC

By ESA Date 6-2-78 Subject STABILITY ANALYSIS Sheet No. 1 of 6
Chkd. By EE Date 6-5-78 LLOYDELL DAM Proj. No. 78-114-1

0.5cm. X 0.5cm.

STABILITY WITH RESPECT TO OVERTURNING
— (NORMAL POOL)



PRESSURE AT UPSTREAM END = γh
= 62.4 × 61 = 3806 PSF
= 3.8 KSF

TOTAL FORCE = $\frac{1}{2}(3806) \times 61$ = **116 K/FT**

F = 116 KIPS FOR A 1 FOOT SECTION

THE UPLIFT PRESSURE AT THE BASE OF THE DAM VARIES FROM 2/3 HYDROSTATIC HEAD AT THE UPSTREAM END TO ZERO AT THE DOWNSTREAM END

UPLIFT PRESSURE @ HEEL $= \frac{2}{3} \times 62.4 \times 61 = 2538$ PSF

UPLIFT " @ TOE = 0

FORCE $= \frac{1}{2}(2538) \times 42 \cong$ **53 KIPS**

STABILITY WITH RESPECT TO OVERTURNING

FACTOR OF SAFETY AGAINST OVERTURNING

$=$ RESISTING MOMENT ABOUT "C" / OVERTURNING MOMENT ABOUT "O"

RESISTING MOMENTS:

$\left[\left(\frac{1}{2}(35) \times 52.5\right) \times .150\ ^{K}/_{FT^3}\right] \times 23.33 = 3215$ FT-K

$+$

$\left[63 \times 7 \times .150\right] \times 38.5 = 2546$ FT-K

$= 5761$ FT-K

OVERTURNING MOMENT:

$116 \times 20.3 = 2355$ K-FT

$+$

$53 \times 28 = 1484$ K-FT

$= 3839$ K-FT

$FS = \frac{5761}{3839} =$ **1.5**

FOUNDATION SHEAR STRESS $= \frac{116^{K}}{42 \times 144} = 0.019\ ^{K/IN^2} =$ **19 PSI**

D'APPOLONIA
CONSULTING ENGINEERS, INC

By ESH Date 6-2-78 Subject STABILITY ANALYSIS Sheet No. 3 of 6
Chkd. By RE Date 6-5-78 LLOYDELL DAM Proj. No. 78-114-12
0.5cm. X 0.5cm.

FOUNDATION PRESSURE

(LOCATE RESULTANT ON BASE)

COMPONENT	A	$\bar{x}$	$\bar{x}A$
RECTANGLE	441	3.5	1543.5
TRIANGLE	918.8	18.7	17181.6
	$\Sigma A = 1359.8$		$\Sigma \bar{x} A = 18725.1$

$\bar{x}\,\Sigma A = \Sigma \bar{x} A$ $\qquad \bar{x} = \frac{18725.1}{1359.8} = 13.8'$ FROM X

TAKING MOMENT ABOUT X

$\Sigma M_x = 0$ $\circlearrowleft +$

$R_y x - 116 \times 20.3 - 66 \times 3.5 - 138 \times 18.7 + 53 \times 14 = 0$

$(R_y = 204 - 53 = 151 \text{ KIPS})$

$R_y x = 2355 + 231 + 2581 - 742 = 4425$

$x = \frac{4425}{151} = 29.3$

∴ RESULTANT IS OUTSIDE MIDDLE THIRD

$e = 29.3 - 21.0 = 8.3$

$q_{MAX} = \frac{\Sigma V}{BL}\left(1 + \frac{6e}{L}\right) = \boxed{7.9 \text{ K/FT}^2}$

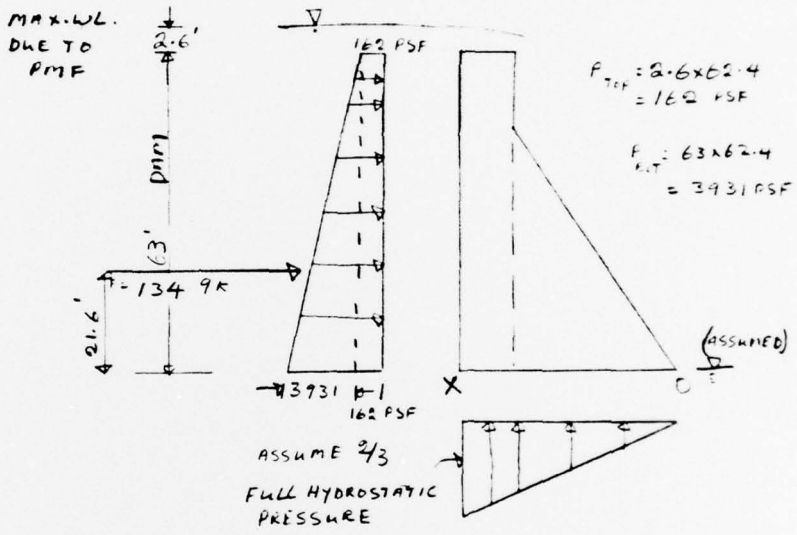
$q_{MIN} = \frac{\Sigma V}{BL}\left(1 - \frac{6e}{L}\right) = \boxed{-0.7 \text{ K/FT}^2}$

D'APPOLONIA
CONSULTING ENGINEERS INC

By ESA Date 6-3-78 Subject STABILITY ANALYSIS Sheet No 4 of 6
Chkd. By BC Date 6-5-78 LLOYDELL DAM Proj. No 72-114-1.2
0.5cm. X 0.5cm.

STABILITY WITH RESPECT TO OVERTOPPING

– 2.6' OVERTOPPING DUE TO PMF



TOTAL FORCE = $\frac{1}{2}(3931 \times 63) + 63 \times 162 = 134$ KIPS

LOCATE CENTROID OF PRESSURE DIAGRAM

COMPONENT	A	$\bar{y}$	$\bar{y}$ A
RECTANGLE	10206	31.5	321489
TRIANGLE	123826	21.0	2600346
	$\Sigma A = 134032$		$\Sigma \bar{y} A = 2921835$

$\bar{y}$ = 21.8 FT

D'APPOLONIA
CONSULTING ENGINEERS, INC

By ESA Date 6-3-78 Subject STABILITY ANALYSIS Sheet No. 5 of 6
Chkd. By RE Date 6-5-78 LLOYDELL DAM Proj. No. 78114-12
0.5cm. X 0.5cm.

UPLIFT PRESSURE = $\frac{2}{3}$ (4093) = 2728 PSF

TOTAL FORCE = $\frac{1}{2}$ (2728) × 42 = 57 KIPS

STABILITY WITH RESPECT TO OVERTURNING

RESISTING MOMENTS = 5761 K-FT
(PAGE 2)

OVERTURNING MOMENTS:

134 × 21.6 = 2921 K-FT
+
57 × 28 = 1596 K-FT
4517 K-FT

FS = $\frac{5761}{4517}$ = 1.28 SAY 1.3

FOUNDATION SHEAR STRESS

FOUNDATION SHEAR STRESS = $\frac{P_h}{A}$

= $\frac{134^{K}}{42 \times 144}$ = 0.022 K/IN^2

= 22 PSI

TAKING MOMENT ABOUT X

$\Sigma M_x = 0$ $\circlearrowleft +$

$R_y x - 134 \times 21.8 - 66 \times 3.5 - 138 \times 13.7 + 57 \times 14 = 0$

$(R_y = 204 - 57 = 147 \text{ KIPS})$

$\therefore R_y x = 2921 + 231 + 2581 - 798$

$x = 33.6'$

$\therefore$ RESULTANT ON BASE IS LOCATED @ 33.6' FROM POINT X

$\therefore e = 33.6 - 21 = 12.6'$

$q_{MAX} = \frac{147}{42}\left(1 + \frac{6e}{L}\right)$

$= 3.50\,(1 + 1.80) = \boxed{9.8 \text{ K/FT}^2}$

$q_{MIN} = 3.50\,(1 - 1.80) = \boxed{-2.8 \text{ K/FT}^2}$

APPENDIX E

REGIONAL GEOLOGY

APPENDIX E
REGIONAL GEOLOGY

The dam is located on the northwest limb of the northeast-trending Nittany Anticline. The eroded limbs of this anticline form the Allegheny Front, the boundary between the Valley and Ridge physiographic province and the Appalachian Plateau physiographic province. The bedrock under the dam and reservoir is composed of the Mississippian Pocono Group, primarily gray sandstone. The rock strata dip to the northwest into the Wilmore Syncline. These rocks are stratigraphically below the "coal measure" strata of the Pennsylvanian System and contain no mineable coals. Therefore, there is no danger of the dam having been undermined.